

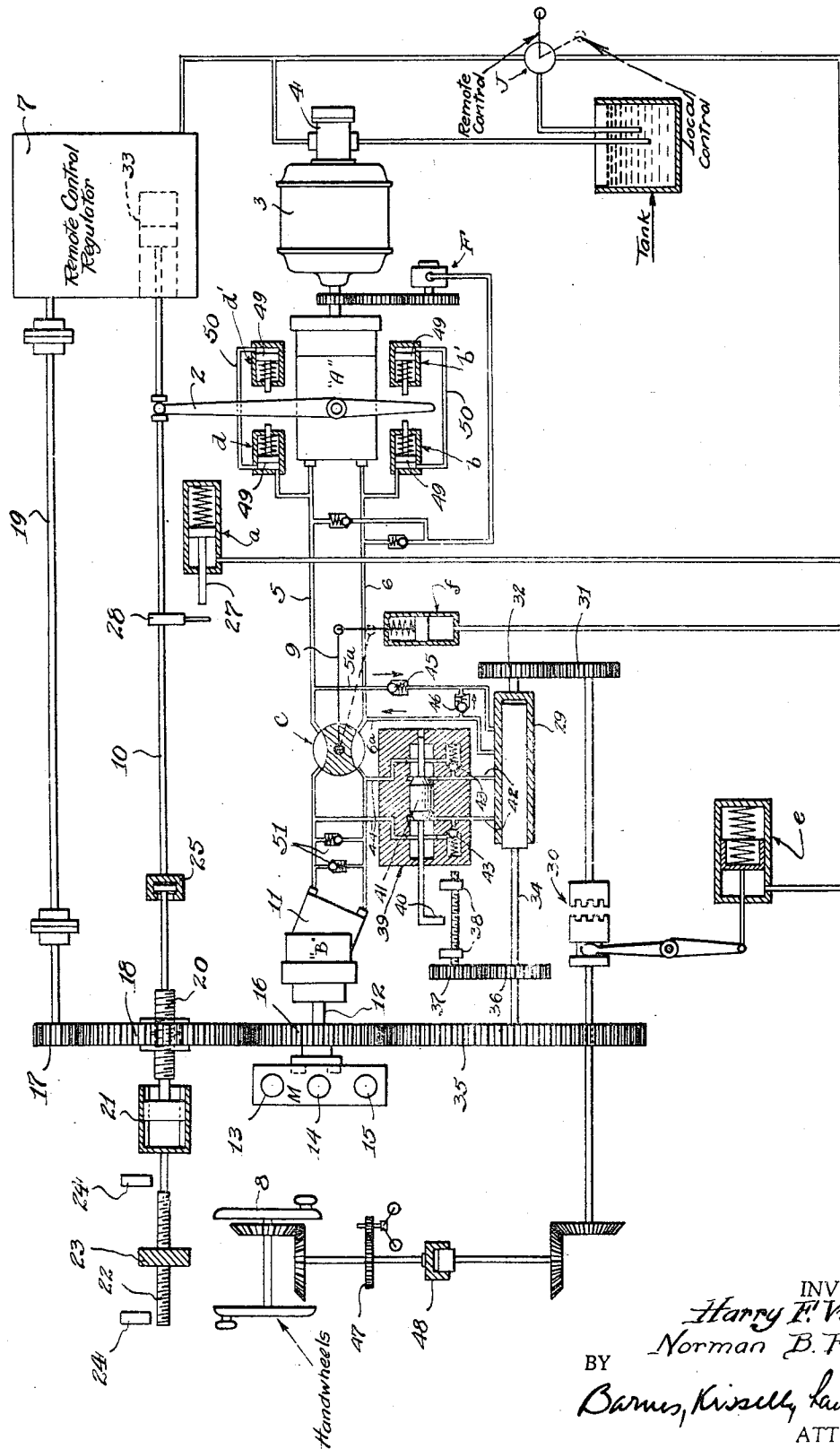
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APPARATUS FOR CONTROLLING THE MOVEMENT OF HEAVY MASSES

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APPARATUS FOR CONTROLLING THE
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This invention relates to an apparatus for controlling the movement of heavy masses, and has to do particularly with a combination of local and remote control means for controlling the movement of heavy masses such as machine tool tables, guns, gun turrets, torpedo tubes, etc.

An important object of the present invention is the provision of efficient and compact means for driving and controlling the movement of heavy masses such as a multiple gun turret by hydraulic power, manual power or a combination of manual and hydraulic power. A further feature includes the provision of means operating as an inherent part of the circuit for preventing or subduing kick back or overhaul due to influence outside of the driving circuit such as the firing of a wing gun in a multiple gun installation.

A further object has to do with combined local and remote hydraulic circuits in combination with means whereby the desired movements of the large mass may be controlled either from a remote station or a local station and common means for preventing or subduing kick back and overhaul irrespective of the point or type of control. Still another feature has to do with the utilization of increased line pressure to reduce any kick back reaction against the source of power; the direct result being the appreciable reduction of the amount of power required.

Other features have to do with various combinations, the individual and combined operations of elements going to make up the combination and various safety features as will be more clearly brought out in the specification and claims.

The drawing represents a diagrammatic flow chart illustrating the various elements and circuits in carrying out local and remote control of the means to be actuated, together with the structure and means for connecting the circuits.

For a clear understanding of the present invention, it should be borne in mind that the present invention embodies a power supply or "A end" consisting of a variable pump driven by an electric motor and an auxiliary constant displacement pump preferably driven by the same motor, a "B end" or hydraulic motor for driving the large mass, and two control circuits, one a remote control and the other a local control connected into the main hydraulic operating system.

The power end of the system is diagrammatically illustrated in the drawing as a main variable pump A, the stroke of this pump being varied by means of a lever 2, an electric motor 3 and a constant displacement auxiliary pump 4. The motor or operating end of the system is designed

as at B and the main lines of the system for supplying operating pressure are designated 5 and 6.

The remote control regulator is indicated as at 7 and the local control indicated generally as at 8. A valve J in one position supplies the fluid power for operating the remote control unit and makes inoperative the local control, and in another position renders the remote control inoperative and the local control operative. A valve C automatically actuated in response to the valve J controls the movement of fluid under pressure between the A end and the B end in accordance with whether the system is remote controlled or local controlled. As will be later explained, both local and remote controls are of the follow up type.

The variable pump A for supplying operating fluid under pressure may be of any standard type, the cam ring or other device for varying the stroke of the piston being movable from open to closed position or vice versa by the lever 2. A small feed pump F keeps the system full of operating fluid, which is preferably oil, at all times. An electric motor 3 of sufficient capacity to normally actuate the mass M is connected to the rotor of the variable pump A and also to the rotor of the constant displacement auxiliary pump 4. In the solid line position of the valve J the auxiliary pump 4 will operate to deliver liquid under pressure to the control parts of the remote control 7 and also against the pistons of the cylinders a, e and f, a and e being rendered inoperative by the application of such pressure and the piston of the cylinder f operating to move the lever 9 to move the valve C into the position shown, which is the "remote" position of the system.

The remote control regulator 7 may be of any standard type such as now being used for controlling gun turrets and other heavy masses from a remote point. Movement of the remote control member will cause actuation of the rod 10 in one direction or the other to actuate the lever 2 to obtain a positive piston stroke in the variable pump A. Fluid pressure will then flow through one of the lines 5 or 6 through the valve C and to the motor B, the angular part 11 of which may be permanently set or may be regulable as desired. Rotation of the driving element 12 of the motor will in turn result in a rotation or swinging movement of the mass M, which mass M, as diagrammatically illustrated, consists of a multiple gun installation 13, 14 and 15. An intermediate gear 16 operated by movement of the shaft 12 is connected to a follow up gear 17 by means

of the gear 18 so as to cause actuation of the follow up shaft 19 which in turn will cause a follow up action of the control member of the remote control unit itself.

5 A limiting stop device of a standard type is provided limiting the movement of the mass M of the remote control regulator 7, the function of which is to cause deceleration and stopping of the mass as it reaches the limit of its stroke and to
10 permit running away of the mass from the stops at full speed. The rod 10 is hydraulically actuated by the remote control regulator and is free to move forward or backward because the connection between the extension of the rod 10 and the
15 gear 18 is by means of a threaded worm 20, the pitch of the threads in the worm 20 being 45° thus permitting movement of the worm axially of the gear 18 by exterior forces. A spline fitting
20 22 carrying a traveling nut 23.

Continued movement of the gear 18 in one direction will cause the traveling nut 23 to contact with one of the limit stops 24 which in turn will hold the spline fitting stationary and cause
25 further movement of the gear 18 to move the worm 20 axially and to return the rod 10 and the lever 2 toward and into neutral position. This action has several functions as will be later described but the main one to be considered here
30 is that this is a decelerating action in that after the nut 23 contacts with the stop the gear 18 will make substantially a complete revolution in returning the lever 2 towards neutral position so that we have this substantially full revolution of
35 the gear and the gradual return of the lever to neutral to slow down the pump and cushion the stopping action of the turret. However, in starting again, the lever 2 can be moved to full open position, with the result that the guns may be
40 moved away from their stopping position at full speed. The connection 25 permits rotation of the worm 20 relative to the reciprocable rod 10.

Now, if the valve J is moved to dotted line position the pump 4 is bypassed and the line 26
45 is connected to the return tank with the result that the cylinders a, e and f are relieved and the springs in the respective cylinders move the pistons in or out, according to the particular design. The lowering of pressure in line 26, for any reason, and relief of line pressure leading to the
50 cylinder a automatically causes the plunger 27 to be moved outwardly until it contacts with and moves a member 28. This action moves the lever 2 forwardly as long as the system is under local control. The reason for this is that in the operation of the system under local control, oil is supplied under pressure in one continuous direction to a rotary follow up valve 29 and reversal of the mass M is obtained by control of the follow up
5 valve instead of reversal of the pump A. Simultaneously with the actuation of the piston 27 the lever 9 will be moved to dotted line position by release of pressure in line 26 and beneath the piston and cylinder f; also the release of pressure
10 in line 26 and at the left of the piston in cylinder e will cause the parts of the clutch member 30 to be brought into operative position. In this condition the hand wheels 8 of the local control will be operative to move the rotary follow up
15 valve one way or the other, the clutch member 30 being connected to the rotary follow up valve by the gears 31 and 32.

The structure of the follow up valve 29 may be that disclosed in detail in application Serial No. 489,812 which has matured into Patent No.

2,030,902; in the present circuit the follow up valve is preferably a closed circuit type. In case the follow up valve is in neutral position resulting increase in pressure because of a closed circuit will return the lever 2 to neutral as will be subsequently described.

It will be understood here that the remote control regulator 7 may be of any standard type, for instance, a follow up valve similar to 29 may be used here to direct the flow of liquid to either
20 end of the cylinder 33.

The outlet shaft 34 in the follow up valve 29 is connected to a gear 35 which meshes with the main gear 16, and also with gear members 36 and 37, the latter two gears operating to actuate
25 the traveling nut units 38 which form a part of the hydraulic limit stop device, generally designated 39. The stop members 38 cooperate with the valve extension 40 of a decelerating valve member 41; this decelerating valve cooperates
30 with the return liquid to the follow up valve to perform its decelerating function. Conduits 42 lead from the rotary follow up valve 29 to seats adjacent each end of the valve 41, when the valve is in neutral position; the two ends of the valve
35 41 are tapered so that movement of the valve one way or the other effects gradual closing of one or the other of the two annular seats which form a termination of the conduits 42. Check valves 43 lead off from the two conduits 42 and control
40 the flow into the conduits 44 which conduits lead to the motor B. The oil under pressure flowing through one of the lines 42 will all flow past one of the check valves 43 and then into one of the lines 44 to the motor B to actuate the same, the return oil will flow through the other line 44 and as it is prevented from flowing into the line 42
45 by the check valve 43 it will flow past a tapered seat on one end of the valve 41. Continued actuation of the motor B and the mass M will result in the traveling nuts 38 moving until one of the same contacts with the extension 40. This will gradually close off the valve seat to automatically decelerate the mass M and then bring the same to a stop. However, reversal of the
50 follow up valve to move the mass in the other direction will result in the flow of oil through one of the lines 42 and past one of the check valves 43 so that movement of the mass in the other direction from the end of the stop will be immediate.

The movement of the valve 41 towards decelerating position is so arranged that deceleration and stopping of the mass M is automatically obtained through the local circuit before the lever
55 2 reaches neutral position by movement of the remote limiting stop device. However, if anything should happen that the local limiting stop device should not work then the remote limiting stop device would move the lever 2 to neutral
60 position to prevent any damage. The hand wheel 8 is moved in either direction to control the flow of oil by means of the rotary follow up valve from the line 5a into either one of the lines 42 and the return of the same from either
65 one of the lines 42 into the line 6a.

Similar to the follow up valve and system explained in application Serial No. 489,812, check valve 45 prevents oil from returning against the pump in case of a kick back from the mass M
70 and the motor B, and check valve 46 permits oil to flow freely from the exhaust side of the system to the pressure side of the system in case of failure by power and the mass M is moved manually.

An inertia governor is diagrammatically illustrated as at 47 and is used to prevent too rapid acceleration or deceleration of the rotary follow up valve which would place undue strain on the power mechanism. This is more clearly explained in application Serial No. 26,800, filed June 15, 1935. As will be presently described, we have provided means for preventing kick back from the mass but as a safety feature against any possible kick back, a kick release 48 is preferably placed in the shaft leading from the hand wheel 8 and consists generally of two parts held together by friction. The friction is great enough so as to carry all ordinary loads in the general actuation of the mass M, but in the event of a kick back, violent motion of the hand wheels is prevented because the parts of the kick release will slip relative to each other.

Assuming that the system is still in local control, we have provided anti-kick structure which may be best understood by describing the operation of the same. Cylinder members *b* and *d* are connected into the lines 5 and 6, each cylinder being provided with spring pressed pistons 49. The springs back of the pistons will normally keep the pistons adjacent the front end of the cylinders. However, if there should be a sudden increase in pressure in the lines either because of kick back from firing one of the wing guns 13 or 15 or by sudden neutralizing of the follow up valve 29, the pistons 49 are moved to the outer end of the cylinders with the result that the lever 2 will return to neutral position. This return of the lever 2 to neutral position is gradual in that the stroke of the variable pump A is gradually shortened so as to build up back pressure to absorb the shock of the kick until neutral position is reached, when, of course, everything is stopped. It will be obvious that if the turret be moved at full speed under full volume of the pump that if kick should occur and the kick absorbed by the pump under full volume the motor, unless it were a very large one, could not absorb the kick back, resulting in stalling or burning out. By automatically and gradually decreasing the stroke in case of a sudden increase in pressure, a small capacity of motor can be used and a shortening of the stroke and building up of the back pressure will prevent such motor from being damaged.

The same cylinders *a*, *b* and *d* operate when the system is in local control to maintain a constant horse power in the variable pump A. Normally the spring in the cylinder *a* tends to open the valve lever 2 to wide open position and the pressure in one of the cylinders *b* or *d* tends to shorten the stroke; therefore it will be seen that the spring in cylinder *a* and the pistons in cylinders *b* and *d* normally counteract each other. The spring in the cylinder *a* is so designed that its resistance increases as it is compressed so it is proportional to an increase in pressure in the cylinders *b* and *d* to move the levers. Generally then it will be seen that with the combination of the spring in the cylinder *a* and the pistons in cylinders *b* and *d*, increase of pressure in the line will shorten the stroke of the variable pump motor and thus cut down the volume, and the load on the electric motor. Due to the design of the spring in the cylinder *a*, it will be seen that the initial movement of the lever towards neutral will be relatively fast, but as the spring is compressed this movement will be slowed up. This action is particularly desirable in connection with the safety kick back as there it is obviously

desirable to have the initial movement of the lever relatively fast and then gradually slow the same up as it approaches neutral position.

To obtain the same anti-kick back safety features when the device is in remote control, we have provided additional cylinders *b'* and *d'* which are connected to the cylinders *b* and *d* as by means of the conduits 50. When the device is in remote control the movement of the turret in one direction or the other is by movement of the lever 2 in one direction or the other, past its neutral position. Inasmuch as either the gun at the point 13 or the one at the point 15 might be fired, it will be seen that the kick back pressure may take place in either the line 5 or 6. Therefore to return the lever 2 to neutral position regardless of the direction of movement or the direction of kick back, the four cylinders *b*, *d*, *b'* and *d'* are so arranged that kick back pressure will be simultaneous in either the cylinders *d* and *d'* or the cylinders *b* and *b'*. Springs in the safety kick back cylinders are also designed to increase in resistance as they are compressed so as to permit relative rapid movement as they approach neutral position and then a positive slowing up. Safety valves 51 are installed for the purpose of relieving the load on the motor B in case the pressure becomes excessive.

It will thus be seen that while the lever 2 may be moved to wide open position to obtain full turret movement of the mass M, any sudden increase in pressure in the lines 5 and 6 due to kick back through the motor B, when the system is either in local control or remote control, or due to movement of the rotary follow up valve 29 to neutral position, will be automatically accompanied by movement of the lever 2 toward neutral position to shorten the stroke of the variable pump A. This beneficial result is obtained by a novel combination of remote and local circuits connecting the variable pump and the motor, and simplified by an auxiliary contact displacement pump. It will also be seen that the automatic movement of the variable pump towards neutral is in direct proportion to the intensity of the pressure developed in the lines 5 and 6.

It will be understood that the valve J may be connected to the remote control regulator 7 or to the local regulator 8 so that the valve is moved into remote control or local control positions simultaneously with the movement of the remote control regulator or the local control regulator.

What we claim is:

1. A hydraulic operating circuit for actuating a relatively large mass, local and remote control means for said circuit, said circuit comprising a variable stroke pump, an electric motor therefor, a hydraulic motor, connections between both sides of said pump and hydraulic motor, pressure responsive means operable when the circuit is either in local or remote control to reduce the stroke of said pump in proportion to the pressure developed in either of said connections, and calibrated means rendered operative when the circuit is in local control and operating in opposition to said pressure responsive means to permit relatively rapid initial reduction of the stroke and then a slower rate of reduction of the stroke as it approaches neutral.

2. A hydraulic operating circuit for actuating a relatively large mass, local and remote control means for said circuit, said circuit comprising a variable stroke pump, an electric motor therefor, a hydraulic motor, connections between both

- sides of said pump and hydraulic motor, and pressure responsive means operable when the circuit is either in local or remote control to reduce the stroke of said pump toward and into neutral position due to sudden development of pressure in either of said connections over and above that required for normal operation of said mass to limit the torque at the electric motor and prevent overloading or stalling, and additional pressure responsive means cooperating with said first named pressure responsive means when the circuit is in local control to maintain a constant horsepower in said pump.
3. A hydraulic operating circuit for actuating gun turrets having a plurality of gun mountings comprising a remote control regulator, local control actuating means, a variable stroke pump, a motor, hydraulic connections between said pump and motor including means for rendering said connections, pump and motor operable as a closed circuit with reversible flow pump or a closed circuit with uni-directional pump, one of said circuits operating in combination with said remote control regulator for said gun turrets and the other in combination with said local control for actuating said turrets, and means responsive to a kick back from any of said guns and an increase in pressure in any of the hydraulic connections between said motor and pump to reduce the stroke of said pump.
4. A hydraulic operating circuit for actuating gun mounts having a plurality of guns comprising a variable stroke pump, a motor, hydraulic connections between said pump and motor including means for rendering said connections, pump and motor operable as a closed circuit with reversible flow pump or a closed circuit with uni-directional pump, and means responsive to a kick back from any of said guns or an increase in pressure in any of the hydraulic connections between said motor and pump to reduce the stroke of said pump.
5. A hydraulic operating circuit for actuating gun turrets having a plurality of gun mountings comprising a remote control regulator, local control actuating means, a variable stroke pump, a motor, hydraulic connections between said pump and motor including means for rendering said connections, pump and motor operable as a closed circuit with reversible flow pump or a closed circuit with uni-directional pump, one of said circuits operating in combination with said remote control regulator for said gun turrets and the other in combination with said local control for actuating said turrets, and means responsive to a kick back from any of said guns and an increase in pressure in the hydraulic connections between said motor and pump to reduce the stroke of said pump, said pressure responsive means being operative irrespective of whether said hydraulic circuit is under local or remote control.
6. A hydraulic operating circuit for actuating a relatively large mass, local control means for said circuit, said circuit comprising a variable stroke pump, a motor, limit stop means rendered operative by the movement of said large mass and including a decelerating valve effective to automatically decelerate the movement of said mass before bringing the same to a stop, and valves operating in combination with said decelerating valve to permit the movement of mass away from its stop position at full speed.
7. A hydraulic operating circuit for actuating a relatively large mass, local and remote control means for said circuit, said circuit comprising a variable stroke pump, a motor, limit stop means rendered operative by the movement of said large mass and including decelerating means effective regardless of whether said circuit is in local or remote control to decelerate the movement of said mass before automatically bringing the same to a stop, and valves operating in combination with said decelerating valve to permit the movement of mass away from its stop position at full speed.
8. A hydraulic operating circuit for actuating a relatively large mass, local and remote control means for said circuit, said circuit comprising a variable stroke pump, an electric motor therefor, a hydraulic motor, connections between said pump and hydraulic motor, pressure responsive means operable to reduce the stroke of said pump in proportion to the pressure developed in said connections, and a closed circuit follow up valve hydraulically connected into the main circuit and forming a part of the local control means, said follow up valve when in normal neutral position setting up a pressure in said connections to automatically return the pump to neutral position.
9. A hydraulic operating circuit for actuating gun turrets having a plurality of gun mountings comprising a remote control regulator, local control actuating means, a variable stroke pump, a motor, hydraulic connections between said pump and motor including means for rendering said connections, pump and motor operable as a closed circuit with reversible flow pump or a closed circuit with uni-directional pump, one of said circuits operating in combination with said remote control regulator for said gun turrets and the other in combination with said local control for actuating said turrets, and an auxiliary constant displacement pump connected to and furnishing fluid under pressure for controlling said means.
10. A hydraulic operating circuit for actuating gun turrets having a plurality of gun mountings comprising a remote control regulator, local control actuating means, a variable stroke pump, a motor, hydraulic connections between said pump and motor including means for rendering said connections, pump and motor operable as a closed circuit with reversible flow pump or a closed circuit with uni-directional pump, one of said circuits operating in combination with said remote control regulator for said gun turrets and the other in combination with said local control for actuating said turrets, spring pressed means rendered operative when said circuit is under local control to increase the stroke of said pump, and means responsive to an increase in pressure in said connections tending to decrease the stroke of said pump, said spring pressed means working in opposition to said pressure responsive means and being so calibrated that the rate of shortening of the stroke due to an increase in pressure is at first relatively rapid and then gradually slows down as it approaches neutral position.
11. A hydraulic operating circuit for actuating gun turrets having a plurality of gun mountings comprising a remote control regulator, local control actuating means, a variable stroke pump, a motor, hydraulic connections between said pump and motor including means for rendering said connections, pump and motor operable as a closed circuit with reversible flow pump or a closed circuit with uni-directional pump, one of said circuits operating in combination with said remote control regulator for said gun turrets and

the other in combination with said local control for actuating said turrets, and pressure responsive spring loaded means for reducing the delivery of the pump in proportion to positive pressure existing at any of said connections.

12. A hydraulic operating circuit for actuating gun turrets having a plurality of gun mountings comprising a remote control regulator, local control actuating means, a variable stroke pump, a motor, hydraulic connections between said pump and motor including means for rendering said connections, pump and motor operable as a closed circuit with reversible flow pump or a closed circuit with uni-directional pump, one of said circuits operating in combination with said remote control regulator for said gun turrets and the other in combination with said local control for actuating said turrets, pressure responsive spring loaded means for reducing the delivery of the pump proportionate to the pressure existing in said connections, and means responsive to excessive loads on the motor and an increase in pressure in said hydraulic connections to reduce the stroke of said pump, said last named means being operative irrespective of the hydraulic connection which directly receives the increase in pressure.

13. A hydraulic operating circuit for actuating gun turrets having a plurality of gun mountings comprising a remote control regulator, local control actuating means, a variable stroke pump, an electric motor therefor, a hydraulic motor, hydraulic connections between said pump and hydraulic motor including means for rendering said connections, pump and hydraulic motor operable as a closed circuit with reversible flow pump or a closed circuit with uni-directional pump, one of said circuits operating in combination with said remote control regulator for said gun turrets and the other in combination with said local control for actuating said turrets, pressure responsive spring loaded means for reducing the delivery of the pump proportionate to the pressure existing in said connections, means responsive to excessive loads on the hydraulic motor and an increase in pressure in said hydraulic connections to reduce the stroke of said pump, said last named means being operative irrespective of the hydraulic connection which directly receives the increase in pressure, and follow up devices operating in combination with said remote control and local control, said follow up devices operating to prevent overload of said electric motor.

14. A hydraulic operating circuit for actuating gun turrets having a plurality of gun mountings comprising a remote control regulator, local control actuating means, a variable stroke pump, a motor, hydraulic connections between said pump and motor including means for rendering said connections, pump and motor operable as a closed circuit with reversible flow pump or a closed circuit with uni-directional pump, one of said circuits operating in combination with said remote control regulator for said gun turrets and the other in combination with said local control for actuating said turrets, means responsive to a kick back from any of said guns and an increase in pressure in the hydraulic connections between said motor and pump to reduce the stroke of said pump, hand wheels for actuating said local control circuit, and an inertia governor and kick release means inserted between said hand wheels and said local control closed circuit, said inertia governor preventing undue acceleration of said

turrets and said kick release being sufficiently strong to permit manual operation of the turrets by said hand wheels but to slip in response to a predetermined kick back pressure.

15. A hydraulic operating circuit for a gun mounting having one or more guns, comprising a pump, a motor connected to said gun mounting, hydraulic connections between said pump and motor, control means for directing the flow of liquid to said motor to cause operation thereof in the desired direction, safety valves for relieving the load on the motor in case the pressure becomes excessive and means to prevent whip that might be produced by an unbalanced movement about the gun trunnions, set up by the movement of the gun or guns and associated parts in recoil, or by the firing of a single gun which would tend to cause whip of the gun or guns about the trunnion, comprising valve means positioned intermediate the pump and motor for automatically resisting any flow from the motor in the wrong direction to protect the pump from excessive pressures when the connections between the pump and motor are open.

16. A hydraulic operating circuit for a gun mounting having one or more guns, comprising a pump, a motor connected to said gun mounting, hydraulic connections between said pump and motor and forming a closed circuit, control means for directing the flow of liquid to said motor to cause operation thereof in the desired direction, safety valves for relieving the load on the motor in case the pressure becomes excessive and means to prevent whip that might be produced by an unbalanced movement about the gun trunnions, set up by the movement of the gun or guns and associated parts in recoil, or by the firing of a single gun which would tend to cause whip of the gun or guns about the trunnion, comprising valve means positioned intermediate the pump and motor for automatically resisting any flow from the motor in the wrong direction to protect the pump from excessive pressures when the connections between the pump and motor are open.

17. A hydraulic operating circuit for a gun mounting having one or more guns, comprising a variable delivery pump, a motor connected to said gun mounting, hydraulic connections between said pump and motor, control means for directing the flow of liquid to said motor to cause operation thereof in the desired direction, safety valves for relieving the load on the motor in case the pressure becomes excessive and means to prevent whip that might be produced by an unbalanced movement about the gun trunnions, set up by the movement of the gun or guns and associated parts in recoil, or by the firing of a single gun which would tend to cause whip of the gun or guns about the trunnion, comprising valve means positioned intermediate the pump and motor for automatically resisting any flow from the motor in the wrong direction to protect the pump from excessive pressures when the connections between the pump and motor are open.

18. A hydraulic operating circuit for a gun mounting having one or more guns, comprising a pump, a motor connected to said gun mounting, hydraulic connections between said pump and motor, control means for directing the flow of liquid to said motor to cause operation thereof in the desired direction, safety valves for relieving the load on the motor in case the pressure becomes excessive, means to prevent whip that might be produced by an unbalanced movement

about the gun trunnions, set up by the movement of the gun or guns and associated parts in recoil, or by the firing of a single gun which would tend to cause whip of the gun or guns about the trunnion, comprising valve means positioned intermediate the pump and motor for automatically resisting any flow from the motor in the wrong direction to protect the pump from excessive pressures, and limit stop means for hydraulically controlling deceleration of the mounting and bringing the same to a stop and permitting movement of the mounting away from its stop position at full speed.

19. A hydraulic operating circuit for a gun mounting having one or more guns, comprising a variable delivery pump, a motor connected to said gun mounting, hydraulic connections between said pump and motor, control means for directing the flow of liquid to said motor to cause operation thereof in the desired direction, safety valves for relieving the load on the motor in case the pressure becomes excessive, means to prevent whip that might be produced by an unbalanced movement about the gun trunnions, set up by the movement of the gun or guns and associated parts in recoil, or by the firing of a single gun which would tend to cause whip of the gun or guns about the trunnion, comprising valve means positioned intermediate the pump and motor for automatically resisting any flow from the motor in the wrong direction to protect the pump from excessive pressures when the connections between the pump and motor are open, limit stop means for hydraulically controlling deceleration of the mounting and bringing the same to a stop and permitting movement of the mounting away from its stop position at full speed, and pressure responsive means operative to maintain a constant horsepower in said variable pump.

20. A hydraulic operating circuit for actuating single or multiple gun mounts comprising a variable displacement pump, a motor connected to the gun mounting, hydraulic conduits connecting each side of the motor with the pump, means for controlling the flow of liquid to and from the motor to cause actuation of the gun mount, safety valves for relieving the load on the motor in case the pressure becomes excessive and anti-kick valve means positioned intermediate the pump and motor and so positioned and arranged as to, resist any back flow of liquid caused by the motor functioning as a pump when the actuating mechanism is stopped, or when the actuating mechanism is operative to resist any back flow from the motor due to kick back from the gun mounting to protect the pump from excessive pressure, or to resist the rotation of the motor in the event of an increase in pressure due to a kick ahead.

21. A hydraulic operating circuit for actuating a gun mount and the like, comprising a variable displacement pump, a motor connected to the gun mount, hydraulic circuits connecting each side of the motor with the pump, means for controlling the flow of liquid to and from the motor to cause actuation of the gun mount, means positioned and arranged to decrease the stroke of the variable displacement pump upon a predetermined increase in pressure in the circuit, and means operatively associated with said last named means and operating as horsepower limiting means upon the increase of pressure beyond said predetermined amount.

22. A hydraulic operating circuit for actuating a relatively large mass, local and remote control

means for said circuit, said circuit comprising a variable stroke pump, an electric motor therefor, a hydraulic motor, connections between both sides of said pump and hydraulic motor, pressure responsive means operable when the circuit is either in local or remote control to reduce the stroke of said pump in proportion to the pressure developed in either of said connections, and calibrated means rendered operative when the circuit is in local control and operating in opposition to said pressure responsive means.

23. A hydraulic operating circuit for actuating single or multiple gun mounts comprising a variable displacement pump, a motor connected to the gun mounting, hydraulic conduits connecting each side of the motor with the pump, means for controlling the flow of liquid to and from the motor to cause actuation of the gun mount, safety valves for relieving the load on the motor in case the pressure becomes excessive, and anti-kick means positioned and arranged to resist any back flow of liquid caused by the motor functioning as a pump when the actuating mechanism is stopped, or when the actuating mechanism is operative to resist any back flow from the motor due to kick back from the gun mounting and to resist the rotation of the motor in the event of an increase in pressure due to a kick ahead.

24. A hydraulic operating circuit for actuating a gun mounting, comprising a pump, a motor connected to said gun mounting, hydraulic connections between said pump and motor, control means for directing the flow of liquid to said motor to cause operation thereof in the desired direction, safety valves for relieving the load on the motor in case the pressure becomes excessive, and a valve unit positioned intermediate the pump and motor and comprising a sliding valve, hydraulic passageways in said unit arranged to direct liquid under pressure around one side or the other of said valve to and from said motor, check valves in said passageways positioned between the sliding valve and the pump, said sliding valve and check valves cooperating to automatically resist any back flow from the motor in the wrong direction when the pump is operatively connected to the motor.

25. A hydraulic operating circuit for actuating a gun mounting, comprising a pump, a motor connected to said gun mounting, hydraulic connections between said pump and motor, control means for directing the flow of liquid to said motor to cause operation thereof in the desired direction, safety valves for relieving the load on the motor in case the pressure becomes excessive, and a valve unit positioned intermediate the pump and motor and comprising a sliding valve, hydraulic passageways in said unit arranged to direct liquid under pressure around one side or the other of said valve to and from said motor, check valves in said passageways positioned between the sliding valve and the pump, said sliding valve and check valves cooperating to automatically resist any back flow from the motor in the wrong direction set up by the movement of the gun or guns about the trunnion when the pump is operatively connected to the motor.

26. A hydraulic operating circuit for actuating a relatively large mass, local and remote control means for said circuit, said circuit comprising a motor for actuating said mass, a pump for furnishing power to said motor, means for normally connecting said motor to said remote control means for direct control thereby, follow-up

valve means positioned intermediate said pump and motor, means to connect the local control means to said follow up valve means, pressure actuated means for normally maintaining said circuit responsive to the remote control means only, said pressure actuated means being so constructed and arranged to automatically operate upon a reduction of pressure supply thereto to remove said pump from direct operative connection with said remote control means, to bring said follow-up valve means into circuit with said pump and motor and to operatively engage said local control means with said follow-up valve means, whereby said local means controls said mass during said reduction of pressure supply.

27. A hydraulic operating circuit for actuating a relatively large mass, local and remote control means for said circuit, said circuit comprising a motor for actuating said mass, a pump for furnishing power to said motor, means for normally connecting said motor to said remote control means for direct control thereby, follow-up valve

means positioned intermediate said pump and motor, means to connect the local control means to said follow up valve means, pressure actuated means for normally maintaining said circuit responsive to the remote control means only, said pressure actuated means being so constructed and arranged to automatically operate upon a reduction of pressure supply thereto to remove said pump from direct operative connection with said remote control means, to bring said follow-up valve means into circuit with said pump and motor and to operatively engage said local control means with said follow-up valve means, whereby said local means controls said mass during said reduction of pressure supply, and means forming a part of said circuit to resist any back flow from the motor due to kick back and to resist rotation of the motor in the event of a kick ahead regardless of whether said circuit is under remote or local control.

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